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EFFECTS OF SELECTED MICRONAIRE LEVELS OF 'ACALA 1517' COTTON ON THE QUALITY OF RING AND OPEN-END YARNS

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EFFECTS OF SELECTED MICRONAIRE LEVELS OF 'ACALA 1517' COTTON ON THE QUALITY OF RING AND OPEN-END YARNS

By Henry H. Perkins, Jr., and Jefferson D. Bargeron III[1]

ABSTRACT

Bales of a genetically fine-fibered cotton, 'Acala 1517', were blended at micronaire levels of 3.0, 3.3, 3.9, and 4.4 to make lots for mill processing. Tests were conducted on each lot to determine the fiber properties of raw stock and finisher-drawing sliver, the opening, picking, and carding wastes and nep contents of processed cottons, and the properties of ring and open-end yarns. Variations in the fiber properties of raw stock for the four selected micronaire levels were small. Variations in fiber properties were greater for finisher-drawing sliver than for raw stock, reflecting the different effects that processing has on fibers of varying maturity. The micronaire levels of finisher-drawing sliver were higher than those of corresponding raw stock, apparently a result of breakage and subsequent removal of the low-maturity (low-micronaire) fibers as waste during processing. From a practical standpoint, opening, picking, and carding wastes were similar for the four micronaire levels, although the waste level was significantly lower for the 3.3-micronaire cotton. Card neps were highest for the 3.0-micronaire cotton and lowest for the 4.4-micronaire cotton. The effects of micronaire level on processing and yarn quality were more pronounced for the ring yarns than for the open-end yarns. For the ring yarns, as micronaire level increased, spinning end breakage increased, strength decreased, elongation decreased, evenness remained the same, wet-processing losses decreased, and dyeing quality improved. With the exception of dyeing quality and wet-processing losses, the performances of the 3.0- and 3.3-micronaire cottons were equal or superior to those of the cottons inside the premium micronaire range (3.5 to 4.9). Therefore, cottons with micronaire levels outside the premium range may perform equally as well as those inside the premium range. In this study, differences in micronaire levels inside the premium micronaire range caused significant differences in processing and yarn quality. **KEYWORDS: 'Acala 1517' cotton, dyeing quality, micronaire levels, spinning performance, wet-processing losses, yarns.**

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INTRODUCTION

Micronaire reading is a measure of fiber fineness, or combinations of fineness and maturity of cotton. Because the dominant varieties of American Upland cotton have similar genetic fineness characteristics, the range that occurs in micronaire reading is generally related to maturity, i.e., the higher the micronaire reading, the greater the maturity. Variations in micronaire reading associated with growth area, crop year, method and time of harvest, etc., are caused by variations in maturity. Therefore, we would expect that maturity can be predicted from micronaire reading, and this, in practice, is actually the case. Generally, cottons with micronaire readings below 3.5 can be classed as immature, those from 3.5 to 4.0 as intermediate in maturity, those from 4.1 to 4.5 as mature, and those above 4.5 as very mature. Certain varieties having exceptional genetic characteristics of fineness or coarseness may not conform precisely to this pattern.

Past studies (*2–4, 6, 7*)[2] have shown that, in producing ring yarns, the adverse effects of low micronaire levels are excessive fiber breakage, high levels of neps in carding, poor yarn appearance, and poor dyeing characteristics. The adverse effects of very low micronaire levels (below 3.0) are poor general performance related to stickiness in processing, low production rate, and high manufacturing weight loss. Conversely, cottons with low micronaire readings often contribute positively to fewer ends down in spinning and higher yarn strength, particularly for finer yarns. The effects of micronaire levels on the production and quality of open-end yarns are not well defined.

Results and conclusions reported for micronaire studies vary widely. The effects of micronaire level on production and yarn quality are much different, depending on the yarn size produced. When producing coarse yarns, the contributions of the low micronaire cottons to lower spinning end breakage and yarn strength are overshadowed or leveled by the large number of fibers in the yarn cross section, and the esthetic properties of evenness and uniform dyeability associated with higher micronaire cottons become dominant. When producing fine yarns, the number of fibers in the cross section of yarn is a controlling factor in governing production and quality, and the positive contribution of the low micronaire cottons is then greater. Thus, if two sizes of yarn are produced from a series of cottons having a range of micronaire levels, the production and quality results conceivably could be much different. Figure 1 shows the results of a USDA study in which both 30s (20 tex) and 40s (15 tex) yarns were produced from the same cottons (*5*). For 40s yarn, as micronaire reading increased, the number of ends down per 1,000 spindle-hours (EDMSH) increased and yarn appearance improved. Break factor decreased initially and then leveled off. For 30s yarn, as micronaire reading increased EDMSH decreased and yarn appearance improved. Break factor decreased initially and then increased.

Within certain yarn fineness limits, the detri-

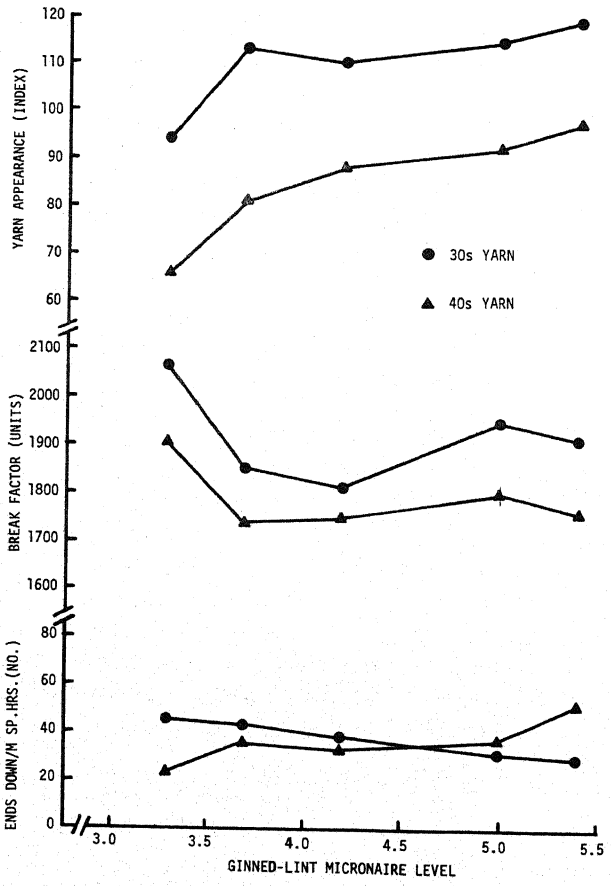

FIGURE 1.—Effects of micronaire levels on yarn quality of two sizes of yarn.

[2] Italic numbers in parentheses refer to items in "Literature Cited" at the end of this publication.

mental effects of high micronaire levels on processing quality can be offset or minimized if cottons of sufficient length are used to insure that the spinning limit of the cotton is not approached. However, if fiber length is at a critical level, spinning end breakage will increase and yarn strength will decrease as micronaire level increases. Figure 2 shows results of experiments in which 40s yarns were produced from cottons of different length over a range of micronaire levels. For the long cotton, as micronaire level increased, spinning end breakage and yarn break factor remained the same. However, for the short cotton, as micronaire level increased, spinning end breakage increased and yarn break factor decreased.

In the current cotton marketing system, micronaire readings in the range of 3.5 to 4.9 constitute a premium range, and cottons with micronaire readings outside this range are discounted. The inference is that cottons inside this premium range should possess similar qualities related to use value and that cottons outside this range should be inferior to those inside the range.

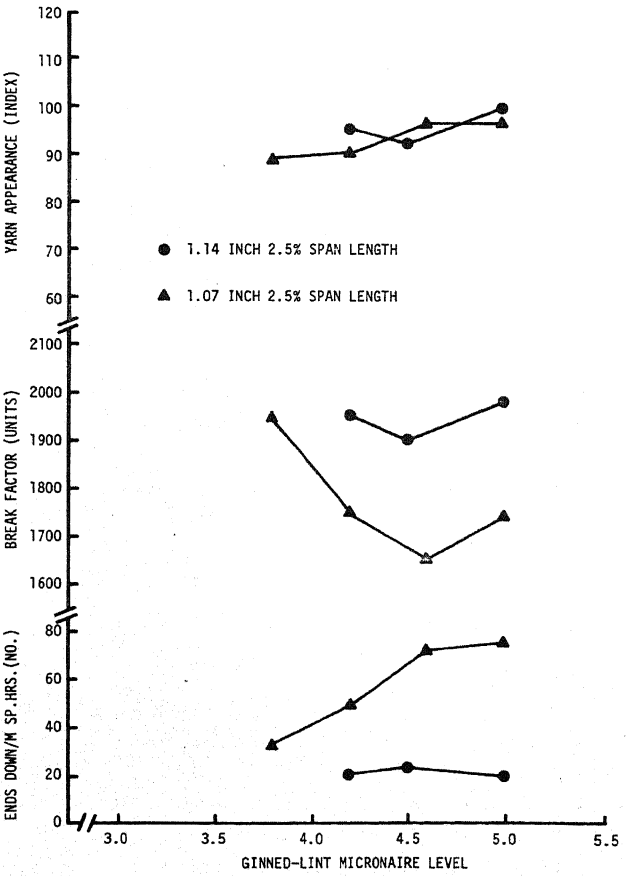

FIGURE 2.—Effects of micronaire levels on quality of yarns produced from cottons of different length.

The objective of this work was to determine the effects on spinning quality of selected micronaire levels, both below and within the premium range, using the genetically fine-fibered variety 'Acala 1517'.

MATERIALS AND METHODS

Mill-Processing Organization

The test cottons, selected on the basis of fiber properties, were purchased commercially. Two bales of similar grade and staple were blended at each of four micronaire levels (3.0, 3.3, 3.9, and 4.4) to make three lots for mill processing. Lots were randomized among micronaire levels. The following processing organization was used:

Picker	14-ounce lap.
Card	55-grain sliver, 20 lb/h.
Breaker drawing	8 ends up, 42-grain sliver.
Lap winder	20 ends up, 806-grain lap.
Comber	53-grain sliver, 14 pct noils.
Finisher drawing	8 ends up, 55-grain sliver.
Roving	1.50 hank, 1.20 twist multiplier.
Ring spinning	60s (10 tex) yarn, 3.10 twist multiplier, 13,000-r/min spindle speed, 10,040-spindle-hour test.
Open-end spinning	18s (33 tex) yarn, 5.0 twist multiplier, 46,000-r/min rotor speed.

Fiber and Yarn Tests

Fibrograph-length, Pressley-strength, and micronaire-fineness measurements were made on ginned lint from bales before blending and on finisher-drawing sliver. One measurement of skein strength and yarn size was made on each of 40 bobbins from ring spinning and two measurements on each of 20 tubes from open-end spinning for each spinning lot. Ten single-strand strength measurements were made on each of 40 bobbins of ring yarn and 20 measurements on each of 20 tubes of open-end yarn for each spinning lot. For each type of yarn, yarn grade was determined from three yarn boards per spinning lot by three technicians. Sixteen

TABLE 1.—*Fiber properties of raw stock and finisher-drawing sliver*[1]

Raw stock				Finisher-drawing sliver			
Micronaire level	2.5-pct span length (inches)	Length uniformity (pct)	Strength, ⅛-inch gage (g/tex)	Micronaire level	2.5-pct span length (inches)	Length uniformity (pct)	Strength, ⅛-inch gage (g/tex)
3.0	1.17a	43a	28.3a	3.2	1.23b	52b	25.5b
3.3	1.19a	44a	28.0a	3.8	1.27a	53b	26.5a
3.9	1.17a	44a	25.9b	4.1	1.25ab	52b	24.4c
4.4	1.18a	44a	26.6ab	4.5	1.25ab	54a	25.3b

[1] Means in a column not having a letter in common are significantly different at the 5-pct level.

bobbins were tested for yarn evenness and imperfections for each yarn. The sensitivity of the tester was set at 30 percent for thin places and at setting No. 4 for thick places and neps. Yarn from each bobbin was tested at 25 yards per minute for 5 minutes (2,000 yards per lot). The number of imperfections per 1,000 yards was also recorded.

Wet-Processing and Dyeing Tests

The wet-processing weight losses of ring yarns were determined by weighing skeins before and after caustic boiloff and peroxide bleach. Dyeings were conducted on knit tubes of ring yarns and on skeins of open-end yarns. The dyes used were Direct Red 81, which accentuates maturity differences, and Direct Green 26, which tends to mask maturity differences.[3] The Gray Scale (*1*) was used to determine color differences. Each Gray Scale value is equivalent to a color difference calculated from Adams' chromatic-value formula (*1*).

Statistical Analysis

An analysis of variance, in conjunction with Duncan's new multiple-range test, was used to determine statistical significance of the differences in means among processing and yarn-quality data for the micronaire levels.

RESULTS

Raw Stock, Finisher-Drawing Sliver, and Processed Cottons

Average fiber properties of raw stock and finisher-drawing sliver are shown in table 1. Variations in the fiber properties of raw stock for the four micronaire levels were small. No significant differences existed for length and length uniformity, but strength of the 3.9-micronaire cotton was lower than that of both the 3.0- and 3.3-micronaire cottons. Variations in fiber properties among micronaire levels were greater for finisher-drawing sliver than for raw stock, reflecting the different effects that processing has on fibers of varying maturity. The micronaire levels of finisher-drawing sliver were higher than those of corresponding raw stock. This was apparently a result of breakage and subsequent removal of the low-maturity (low-micronaire) fibers as waste during processing.

TABLE 2.—*Effects of micronaire levels on opening, picking, and carding wastes and nep contents of processed cottons*[1]

Micronaire level	Opening, picking, and carding waste (pct)	Neps (No. per 100 inch² of card web)
3.0	2.6a	18c
3.3	2.4b	12b
3.9	2.7a	11b
4.4	2.7a	5a

[1] Means in a column not having a letter in common are significantly different at the 5-pct level.

No difficulties were encountered during processing of these cottons. From a practical standpoint, opening, picking, and carding wastes were similar for the four micronaire levels, although the waste level was significantly lower for the 3.3-micronaire cotton (table 2). Card neps were highest for the 3.0-micronaire cotton and lowest for the 4.4-micronaire cotton.

[3] Dyes from Color Index of the American Association of Textile Chemists and Colorists.

TABLE 3.—*Effects of micronaire levels on ring-yarn properties*[1]

Micronaire level	EDMSH[2]	Break factor	Single-strand strength (g/tex)	Elongation (pct)	Yarn appearance index	Evenness (pct)
3.0	22a	2,310a	14.7a	5.6a	99a	18.9a
3.3	22a	2,202b	14.2a	5.2ab	102a	18.8a
3.9	49b	1,946c	13.4b	5.0b	109a	19.0a
4.4	70c	1,851d	12.8b	4.9b	110a	19.1a

[1] Means in a column not having a letter in common are significantly different at the 5-pct level.
[2] Ends down per 1,000 spindle-hours.

TABLE 4.—*Effects of micronaire levels on dyeing quality and wet-processing weight losses of ring yarns*

Micronaire level	AATCC color ratings[1]				Wet-processing weight loss[2] (pct)
	Direct Red 81		Direct Green 26		
	Gray Scale value	Color difference (units)	Gray Scale value	Color difference (units)	
3.0	3–4	2.1	4	1.5	6.92a
3.3	4	1.5	4–5	.8	5.92b
3.9	4–5	.8	4–5	.8	5.63c
4.4	5	...	5	...	5.61c

[1] Color ratings of the American Association of Textile Chemists and Colorists.
[2] Means not having a letter in common are significantly different at the 5-pct level.

Ring Yarns

The effects of micronaire levels on ring-yarn properties are shown in table 3. End breakage in spinning was much higher for the 3.9- and 4.4-micronaire cottons than for the 3.0- and 3.3-micronaire cottons. This was the expected result of micronaire effect on fine yarn (60s). Break factor decreased significantly as micronaire increased, resulting in more than 450 units between the 3.0- and 4.4-micronaire levels. Single-strand strength and elongation also decreased as micronaire level increased. The trend in yarn appearance was toward improvement as micronaire increased, but the improvement was not statistically significant. Yarn evenness, as defined by Uster's coefficient of variation, was similar for all yarns. Generally, the performances of the two lower micronaire cottons were superior to those of the two higher micronaire cottons, although the lower micronaire cottons were outside the premium micronaire range and, hence, were discount cottons.

The results of the dyeing tests on ring yarns are shown in table 4. The yarn from the highest micronaire cotton was the darkest and had the best solid shade; therefore, it was assigned a value of 5. Thus, the color-difference units in table 4 represent shade differences between this yarn and yarn from each of the other micronaire levels. A color difference of one unit represents a readily discernible difference in depth of shade. The results show that as micronaire level increased, depth of shade and dyeing quality improved. The effect was more pronounced with the more sensitive red dye.

The dyeing problems related to maturity can be eliminated or minimized by using one or more of the following procedures: (1) Use of dyes which, by either dyeing mechanism or method of application, mask maturity differences, (2) careful selection of direct dyes, (3) use of pastel shades, and (4) strong pretreatment of the cotton with sodium hydroxide. Nevertheless, the low-maturity cottons are more apt to cause dyeing problems and, from a

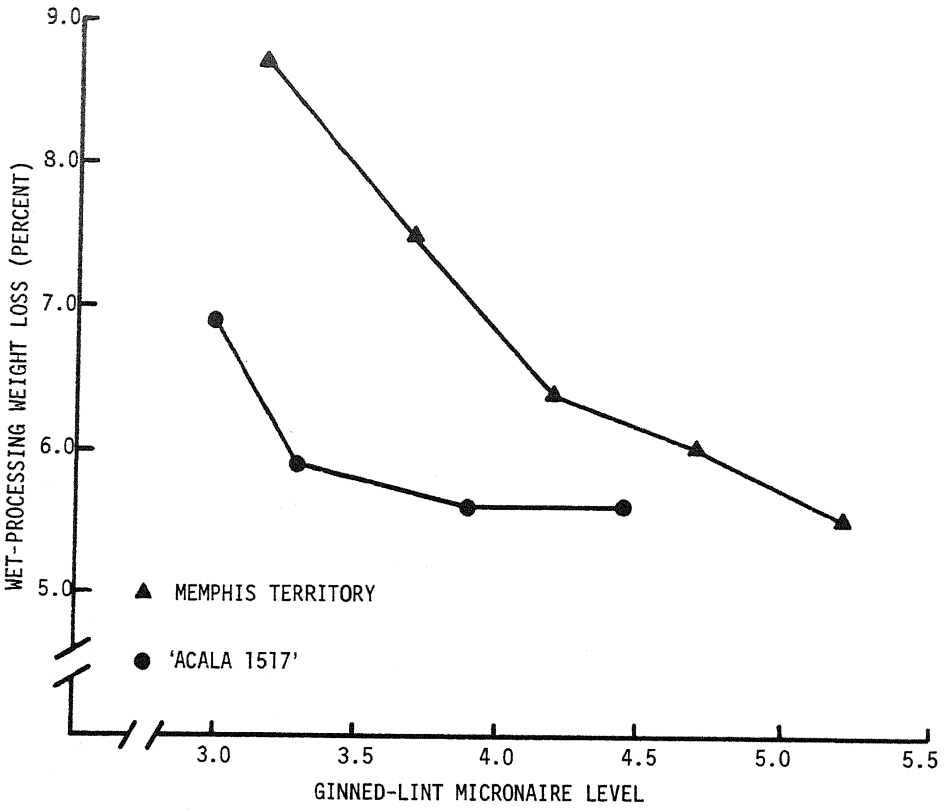

FIGURE 3.—Effects of micronaire levels on wet-processing weight losses of Memphis Territory and 'Acala 1517' cottons.

TABLE 5.—*Effects of micronaire levels on open-end yarn properties*[1]

Micronaire level	Break factor	Single-strand strength (g/tex)	Elongation (pct)	Yarn appearance index	Evenness (pct)
3.0	2,239a	13.4a	6.3a	107a	14.4a
3.3	2,206ab	12.8ab	6.3a	116ab	14.1a
3.9	2,139b	12.8ab	6.0ab	110ab	14.4a
4.4	2,097c	12.2b	5.7b	117b	14.5a

[1] Means in a column not having a letter in common are significantly different at the 5-pct level.

TABLE 6.—*Effects of micronaire levels on dyeing quality of open-end yarns*

Micronaire level	AATCC color ratings[1]			
	Direct Red 81		Direct Green 26	
	Gray Scale value	Color difference (unit)	Gray Scale value	Color difference (unit)
3.0	4–5	0.8	5	None.
3.3	5	None	5	Do.
3.9	5	..do..	5	Do.
4.4	5	...	5	...

[1] Color ratings of the American Association of Textile Chemists and Colorists.

general standpoint, this must be considered a negative quality factor.

Results of the scouring and bleaching tests on ring yarns (table 4) show that weight losses were greater for the 3.0- and 3.3-micronaire cottons than for the 3.9- and 4.4-micronaire cottons. This phenomenon has been observed in previous micronaire studies in our laboratory (*6*). The cotton-fiber surface, as compared with its internal structure, contains a high percentage of noncellulosic materials that can be removed by scouring and bleaching. Thus, low-micronaire cottons, as compared with high-micronaire cottons, lose more weight in wet processing because they have more surface area per unit of weight. Hence, the greater outturn of finished product for the high-micronaire cottons is an economic advantage. 'Acala 1517' is genetically fine cotton and, compared with genetically coarser cottons such as Memphis Territory (fig. 3), has lower weight losses at a given micronaire level.

Open-End Yarns

The effects of micronaire level on open-end yarn properties are shown in table 5. Strength of open-end spun yarns decreased as micronaire increased, as shown by both break factor and single-strand strength measurements. Yarn elongation also decreased as micronaire increased. Yarn appearance improved as micronaire increased, but yarn evenness was not affected by micronaire level. Micronaire level affected open-end yarn quality and ring-yarn quality similarly. The performances of the cottons outside the premium micronaire range were comparable or superior to those of the cottons inside the premium micronaire range.

Results of the dyeing tests on open-end yarns are shown in table 6. The yarn from the 4.4-micronaire cotton was assigned a value of 5, and the yarns from the other cottons were compared with this yarn. For the green dye, which tends to mask maturity differences, no differences in dyeing quality were detected. For the red dye, a slightly lighter shade was observed for the lowest micronaire cotton. Differences in dyeing quality associated with micronaire level were much smaller for open-end yarns than for ring yarns. Similar results were reported by Vaughn et al. (*8*).

SUMMARY

Relatively small changes in micronaire level caused large differences in processing and yarn quality. Micronaire level affected the processing and yarn quality of both ring and open-end yarns spun from 'Acala 1517', a genetically fine-fibered cotton. The effects were more pronounced for the ring yarns than for the open-end yarns. For ring yarns, as micronaire level increased spinning end breakage increased, strength decreased, elongation decreased, evenness remained the same, wet-processing losses decreased, and dyeing quality improved. With the exception of dyeing quality and wet-processing losses, the performances of the two cottons outside the premium micronaire range were equal or superior to those of the cottons inside the premium micronaire range. For open-end yarns, as micronaire level increased break factor decreased, elongation decreased, evenness remained the same, and appearance improved slightly. Dyeing quality was affected only slightly by a dye that is very sensitive to maturity differences and not at all by a dye that masks maturity differences. The performances

of the 3.0- and 3.3-micronaire cottons, which were outside the premium range, were generally equal or superior to those of the cottons inside the premium micronaire range.

Clearly, for the cottons in this study, differences in micronaire levels inside the premium micronaire range caused significant differences in processing and yarn quality. Cottons with micronaire levels outside the premium range may perform equally as well as those inside the premium range. Blanket conclusions concerning micronaire level should not be made without knowledge of the genetic character and intended end use of the cotton. The current cotton-marketing system may impose unwarranted penalties on low-micronaire cottons and may not be sensitive enough to incremental differences in micronaire level that have definite effects on the performance and use value of cotton.

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